BIOLOGICAL EVALUATION OF GYPSY MOTH

at

CAPE MAY NATIONAL WILDLIFE REFUGE

2008

Prepared by

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ABSTRACT

On November 19, 2008, USDA Forest Service personnel conducted a gypsy moth egg mass survey at Cape May National Wildlife Refuge. The purposes of this survey were to determine population densities, assess the potential for defoliation and the need for treatment in 2009. The USDI Fish and Wildlife Service had proposed treatment of eight areas that encompassed approximately 942 acres. Current populations are sufficient to cause light defoliation on 9 acres and heavy defoliation on 851 acres. Treatment is recommended on 860 acres to prevent defoliation, mast reduction, branch dieback and possible tree mortality.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a $1/40^{th}$ acre fixed radius plot was established. The plots consisted of a tally of all the new (2008) egg masses observed on the overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre. Egg mass lengths were measured at the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity.

RESULTS

The location of the survey plots along with the proposed treatment areas are shown in Figures 1a and 1b. The summarized results of the survey are presented in Table 1. In brief, egg mass densities ranged from 0-25,440 and averaged 6558 egg masses per acre. Overall egg mass lengths tended to be moderate in size, ranging from 20-36 mm and averaging 27 mm.

DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as light (30-50 percent) and heavy (51-100 percent). Defoliation less than 30 percent has little impact on trees and cannot be detected through aerial surveys.

The egg mass survey results indicate that light defoliation is likely to occur on 9 acres and heavy defoliation on 851 acres at Cape May National Wildlife Refuge in 2009 (Figures 2a and 2b).

This defoliation prediction is further supported when egg density is used as a means of estimating gypsy moth population densities. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity.

Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (in mm) and egg mass density provides a more precise means of estimating population densities and prediction defoliation. Using Liebhold's model, Figure 3 shows how this information can be used to correlate the predicted defoliation of an area. Accordingly, the estimated egg mass density of 2600 masses per acre (average egg mass density in block #1) x 29 mm (average egg mass length in block #1) translates to a projected defoliation level of about 66 percent (heavy defoliation). Because egg mass densities and the host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately heavy throughout block #1. Heavy defoliation is also predicted for block #s 2, 6, 7 and 8 while light defoliation is predicted for block #3. No noticeable defoliation is expected in block #s 4 or 5.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy throughout most areas surveyed at Cape May NWR. The average egg mass length is 27 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. There was no evidence that either one of these entomopathogens had significant impacts at Cape May NWR in 2008. It is likely that either the gypsy moth fungus or the NPV could cause the collapse of the gypsy moth populations in 2009. However, the collapse may take place after a defoliation event has occurred.

Predicting the extent of tree mortality that would occur after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in access of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light defoliation (<50 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback. In general, trees that are defoliated in excess of 50 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is

compounded. Trees that receive light defoliation (<50 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. Cape May NWR experienced a severe drought during the 2007 growing season and again late in the 2008 growing season. Approximately 323 acres of defoliation were detected at Cape May NWR in 2008.

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) provide examples of the potential tree mortality that can occur. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28 percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak saw timber and 14 percent of the total oak pole timber occurred after one year of moderate to heavy defoliation. In these examples, droughty conditions likely contributed to the level of mortality.

Based on observations of the existing health of the forested areas Cape May NWR and the factors mentioned above, extensive tree mortality is expected if defoliation occurs. Mortality will be more severe if adequate rainfall is not received during the 2009 growing season.

Management Options

In 2009, three management options have been evaluated for managing gypsy moth populations at Cape May NWR. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent mast failure, branch dieback and tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga*. In areas with defoliating levels of gypsy moth populations, viral epizooics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels.

Although it is not possible to accurately assess such events with the defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations information at hand, it is unlikely that a collapse will occur in 2009 since most of these areas are newly infested and there is an abundance of large healthy egg masses.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al., (1996) showed short-term impacts of both species richness and abundance occurred following light defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that light defoliation will occur on 9 acres and heavy defoliation on 851 acres at Cape May NWR in 2009 (Figures 2a and 2b).

Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk)*. This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al., (1996) in West Virginia. Miller's study involved a large scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1 year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½ -1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be

expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 4×10^{11} occlusion bodies (OB's) per acre applied in a single application or 2×10^{11} OB's per acre applied in a double application. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There are, however, sufficient quantities of Gypchek currently available for 2009 should this insecticide be preferred for use at Cape May NWR

Alternatives

With the previously described options in mind, the following alternatives are offered:

Alternative 1. - No action.

Alternative 2. - One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ½ - ¾ gallon per acre.

Alternative 3. - Two aerial applications of *Btk*, as in alternative 2, applied 4-7

days apart.

Alternative 4. - One aerial application of Gypchek at the rate of 4×10^{11} OB's in a total mix of .5-1 gallon per acre.

Alternative 5. - Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of .5-1 gallon per acre per application. The second application should be applied 3-5 days after the first application.

Alternative 6. - One aerial application of DFB at the rate of 0.75 oz formulated material in a total mix of 1 gallon per acre.

RECOMMENDATIONS

As previously stated, gypsy moth populations at Cape May National Wildlife Refuge are sufficient to cause light defoliation on 9 acres and heavy defoliation on 851 acres. To protect tree foliage, mast production and prevent branch dieback and subsequent tree mortality, our recommendation is Alternative 4 (a single application of Gypchek).

This recommendation is based on the following considerations:

1) The US Fish and Wildlife Service would like to use the most host specific insecticide available

2) The New Jersey Department of Agriculture will incorporate Cape May NWR into their 2009 suppression project. Due to the large size of this project and the short biological window for gypsy moth spraying, there will not be any two application blocks in 2009.

3) It is likely that a single application of Gypchek will provide foliage protection on at least 70 percent of the treatment area. However, a significant population reduction is unlikely.

4) It is likely that Btk would provide better results that Gypchek but Gypchek is the preferred insecticide of the Fish and Wildlife Service.

5) Due to the toxicity of DFB to some aquatic invertebrates, and with streams and wetlands in some of the proposed treatment areas, alternative 6 (aerial application of DFB) was eliminated from consideration.

REFERENCES

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Gottschalk, K.W. 1990. Gypsy moth impacts on mast production, *In*: McGee, Charles E. Ed. Proceedings of the Workshop, southern Appalachian Mast Management; 1989 August 14-16; Knoxville TN; University of Tennessee; 42-50.

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Miller, J.C. 1990. Field assessment of the effects of a microbial pest control agent on non-target Lepidoptera. American Entomologist 36:2, 135-139.

Moore, K.E.B. and Jones, C.G. 1987. Field estimation of fecundity of gypsy moth (Lepidoptera: Lymnatriidae). Environ, Entomol. 16: 165-167.

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Table 1 – Gypsy moth egg mass survey results in block #1 at Cape May National Wildlife Refuge, November 19, 2008.

Plot #	# em acre	em size (mm)
1*	1160	20, 26, 22
2*	4160	30, 34, 30
3*	2480	36, 32
4*	4960	36, 34, 30
5*	3640	30, 26, 30
6*	160	--
7*	1640	26, 26, 32
8*	4160	26, 26, 28
9*	6960	30, 26, 26
10*	5080	24, 22, 22,
11*	1120	26
12	160	--
13	0	--
14	0	--
15*	560	28, 26,
16*	17360	30, 26, 26
17*	11480	20, 26, 24
18*	11680	26, 22, 26
19*	10920	20, 26, 26
20*	3760	26, 30, 30
21*	17880	20, 22, 24
22*	25440	24, 30, 24
23*	22640	34, 32, 32
24*	0	--

em/acre range = 0 – 25,440
em/acre average = 6558

em size range (mm) = 20-36
em size average (mm) = 27

* = plot located within recommended treatment blocks

em/acre in recommended treatment blocks = 0-25,440
em/acre average in recommended treatment blocks = 7487

em size range (mm) in recommended treatment block 10 = 20-36
em size average (mm) in recommended treatment blocks = 27

Figure 1a. -- Location of the gypsy moth survey plots established on November 19, 2008, at Cape May NWR along with the 2009 proposed treatment blocks.

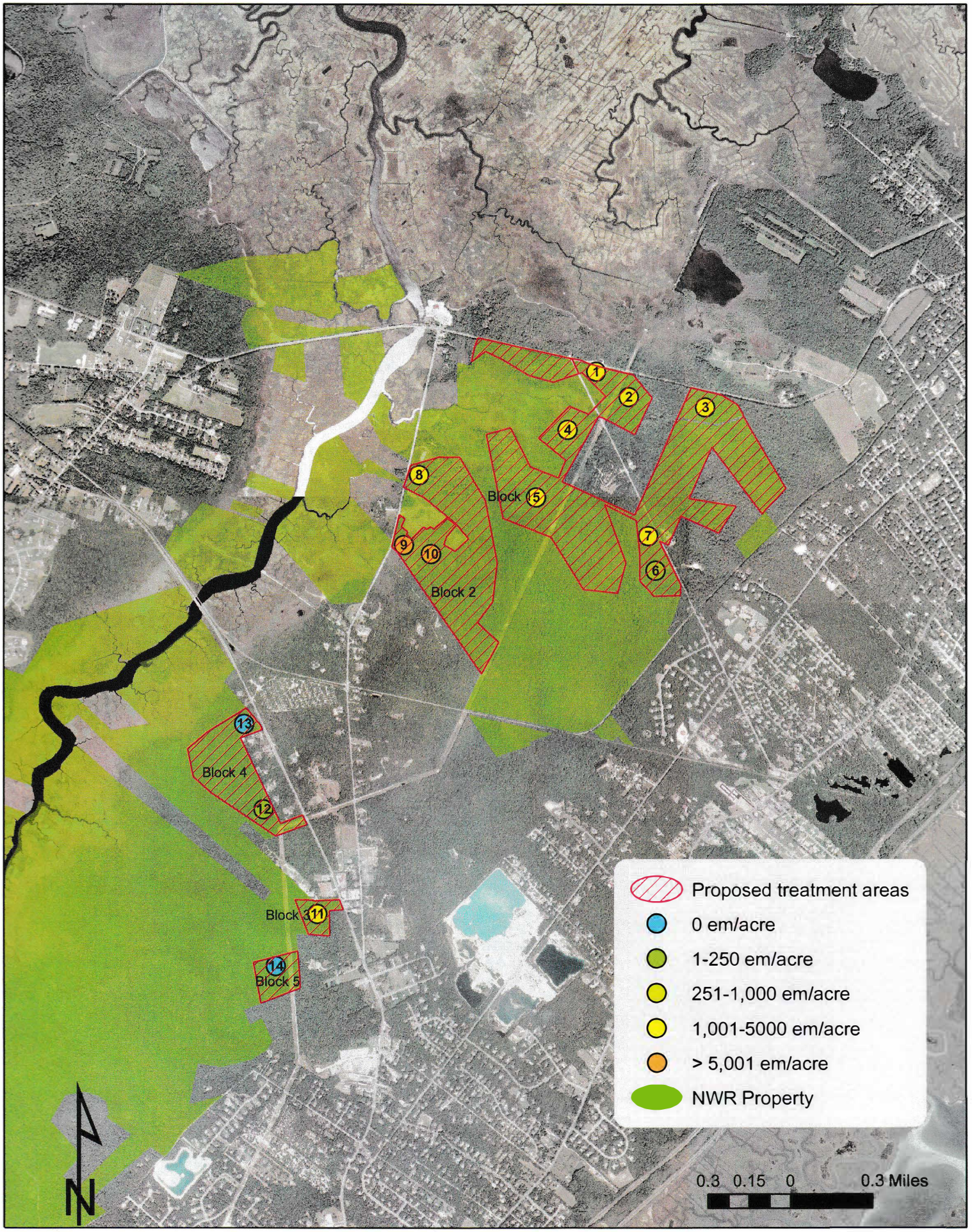


Figure 1b. -- Location of the gypsy moth survey plots established on November 19, 2008, at Cape May NWR along with the 2009 proposed treatment blocks.

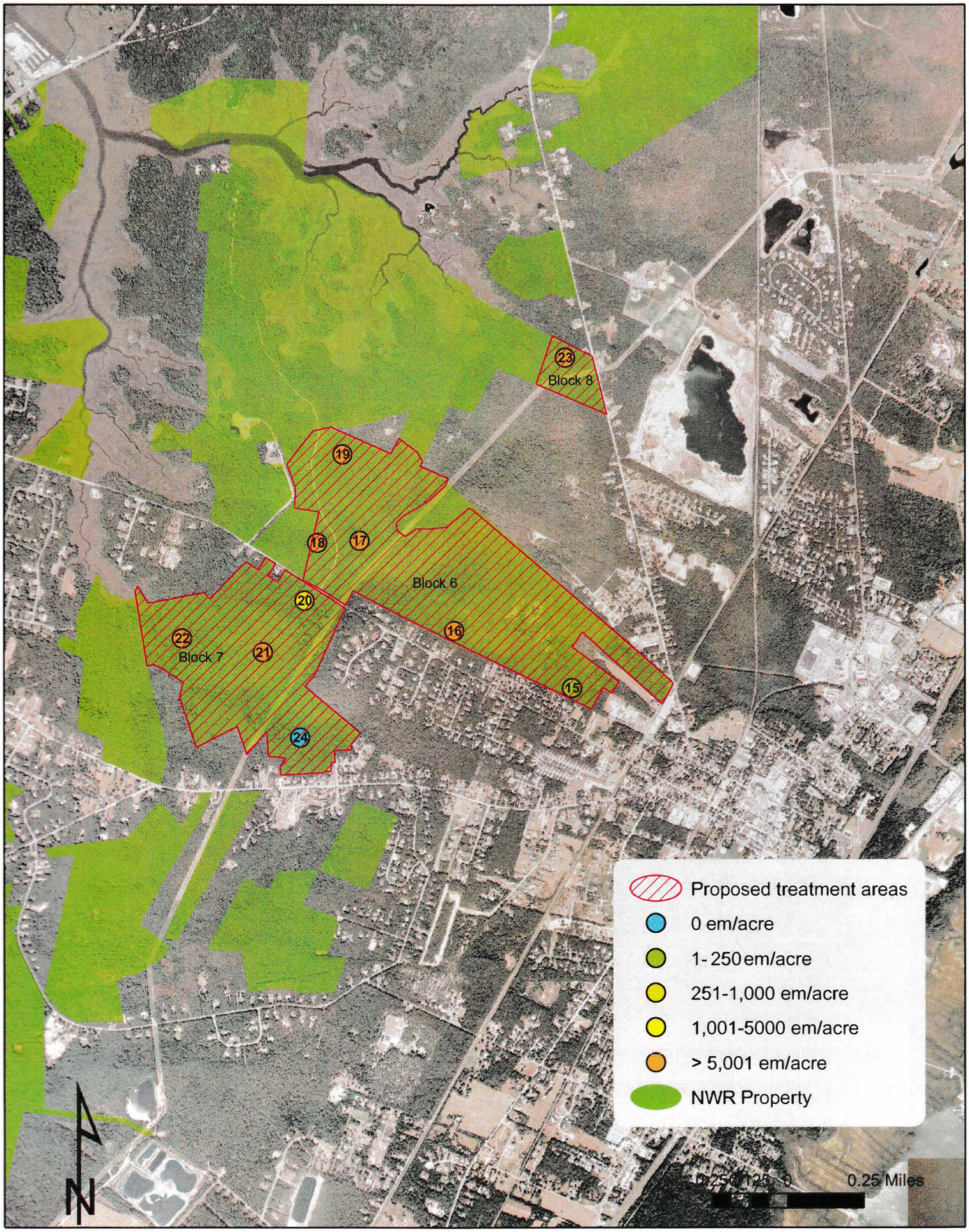


Figure 2a. -- Areas where defoliation is likely/recomended treatment areas.

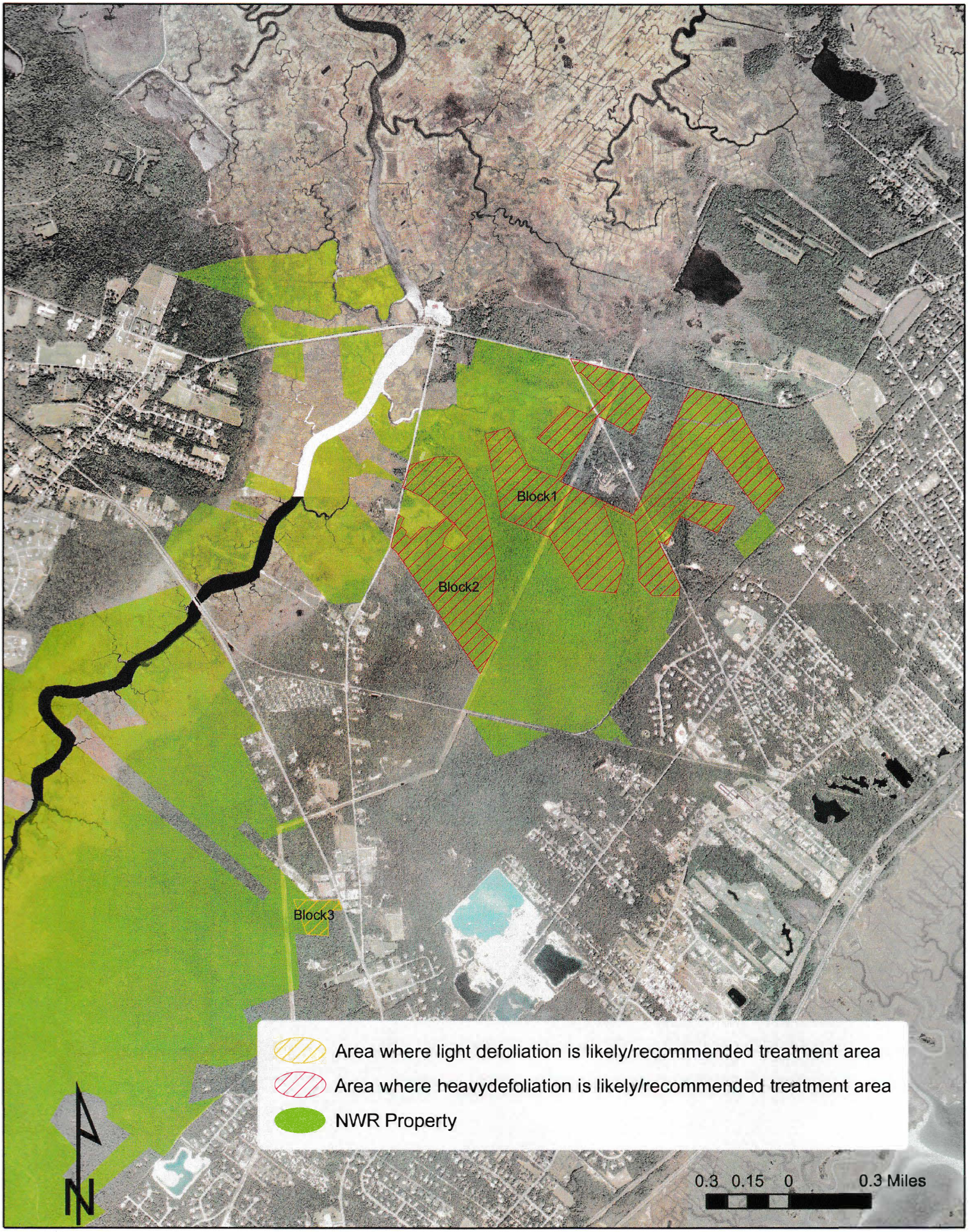
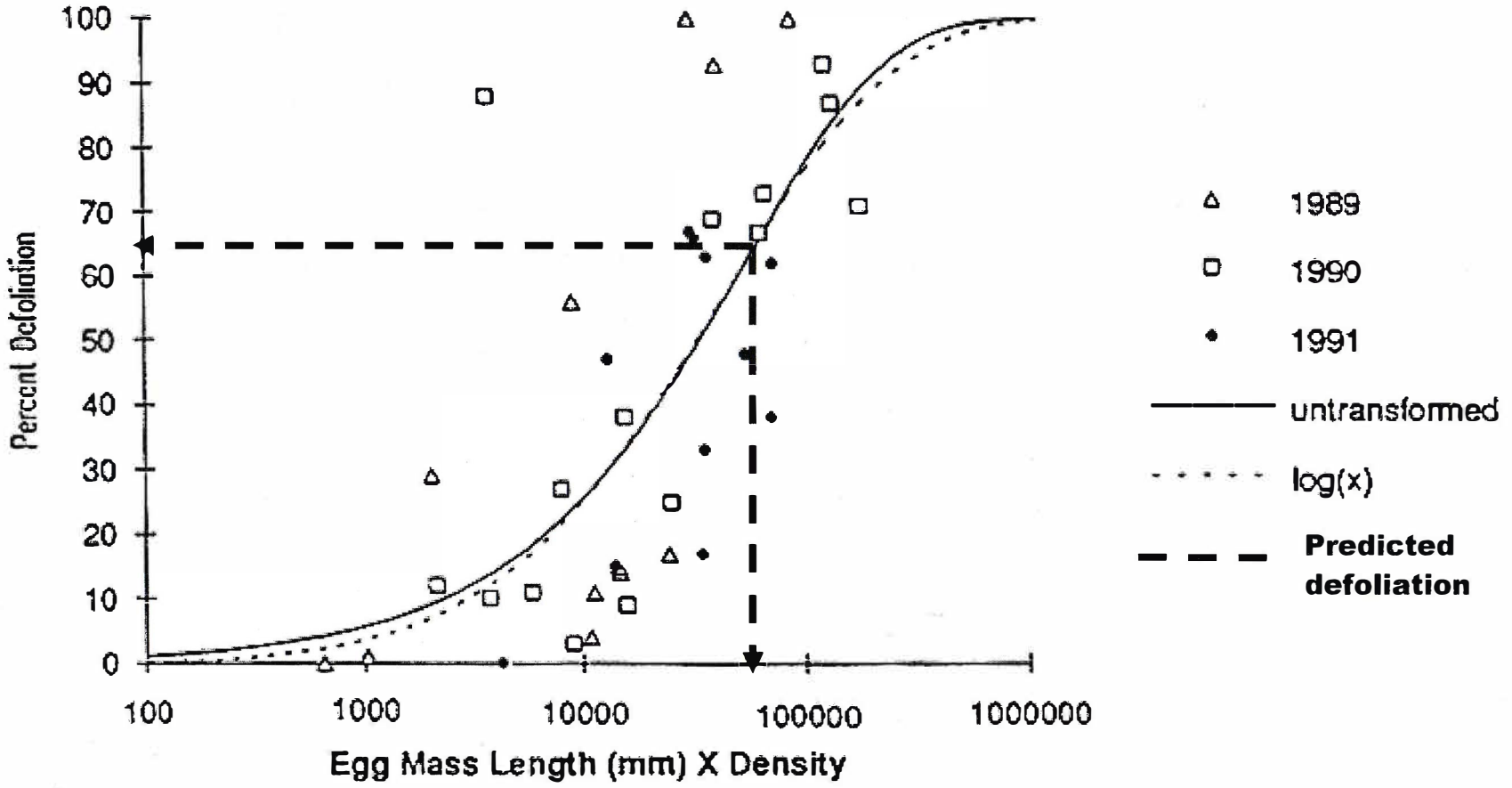


Figure 2b. -- Areas where defoliation is likely/recomended treatment areas.

Figure 3.—Predicted defoliation in block #1 at Cape May NWR in 2009.



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

USDA United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3400
Date: January 6, 2009

Mr. Howard Schlagel, Refuge Manager
Cape May National Wildlife Refuge
24 Kimbles Beach Road
Cape May Court House, NJ 08210

Dear Howard:

Enclosed is the gypsy moth biological evaluation for Cape May National Wildlife Refuge.

In brief, gypsy moth populations are sufficient to cause light defoliation in 9 acres and heavy defoliation on 851 acres. Gypchek, the insecticide selected for use by Cape May NWR, will likely provide adequate results. However, *Bacillus thuringienis* variety *kurstaki (Btk)* would likely provide better foliage protection and is more likely to provide a significant population reduction.

The current plans are for the New Jersey Department of Agriculture to incorporate Cape May NWR into their suppression program in 2009.

Please contact me at 304-285-1555 if you have any questions regarding this gypsy moth biological evaluation.

Sincerely,

Rodney L. Whiteman

RODNEY L. WHITEMAN
Forester
Forest Health Protection

Enclosure

cc: Allen Carter, Regional Forester, USDI F&WS
George Koeck, NJDF
Joe Zoltowski, NJDA
Robert Lueckel, MFO

RLW/blm